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USDA
Plant Genome
Mapping Program

Science and Technology
Coordinating Committee

August 30-31, 1989
Meeting Summary

Issued December 1989

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Preface

In December 1988, a plant genome research conference was held at the initiative of then-Assistant Secretary for Science and Education, Dr. Orville Bentley. After the December conference, Dr. Bentley created the USDA Office of Plant Genome Mapping and appointed Dr. Jerome P. Miksche as the director. As a follow-up to the December conference, the USDA Office of Plant Genome Mapping organized the Plant Genome Research Coordinating Committee consisting of prominent scientists from academia, government, and the private sector. The committee met in Washington, DC, on August 30-31, 1989, and was charged with further defining the goals of the USDA plant genome research initiative and recommending appropriate courses of action and priorities. What follows is the summary of the discussion and recommendations of that committee.

Executive Summary

The group agreed that the USDA initiative on plant genome research has come at an opportune time to help this nation face many challenges in the future of American agriculture. Results from the plant genome research will directly benefit agriculture in development of the kind of crops that withstand adverse growing conditions, require less input of chemicals, possess higher nutritional quality or economic value, or offer alternative uses. There was the strong consensus that USDA is uniquely qualified to undertake this activity. While the NIH/DOE Human Genome Project is expected to produce rapid advances in gene mapping and sequencing technologies, scientific information on the genetic characteristics unique to the plant genome will not be addressed by NIH or DOE.

The committee urged that USDA plan and execute this initiative without delay so that the opportunity presented to USDA will not be missed. USDA was advised to collaborate closely with NSF and the NIH/DOE Human Genome program to take advantage of their scientific and technical advances as well as to avoid unnecessary duplication of effort. Coordination with the existing USDA Competitive Research Grants Office is also important. The involvement of academic, government, and private sector scientists is crucial for the success of this program. Wherever advantageous, an interdisciplinary approach should be encouraged in accomplishing the goals of this program.

The participants identified three major objectives for the USDA plant genome initiative:

Mapping and sequencing of plant genome, including technology development.

Management of database, information, and resources.

Identification, characterization, and expression of genes of agricultural importance as well as gene transfer technology.

Accomplishment of the objectives should be planned in increments without losing sight of the ultimate goal of the plant genome project.

The major role of the USDA Plant Genome Office should be that of coordination and administration. It was recommended that the USDA Plant Genome Office publish a pamphlet that articulates the significance of the plant genome initiative, organize a working group to define the data management aspects of the plant genome program, and engage on a regular basis in discussions with NSF, DOE, and NIH in regard to interagency collaboration. International activities concerning plant genome research should be monitored by the Office as well. The USDA Plant Genome Office should also address social issues associated with genome research as part of its responsibility, although the kind of controversial, ethical issues arising from the human genome research is not expected for plant genome research.

Finally, the group realized the difficult task of convincing the public that this is a worthwhile activity of high priority, and volunteered their services for the cause of this important USDA initiative.

Goal Statement

The goal of the USDA Plant Genome Mapping Project is to address concerns about the environment (for example, global changes and water quality) and to promote stability and profitability of production, improved quality of food/fiber/feed, maintenance of germplasm resources, and new crop plants and forest species. To accomplish this goal, the Plant Genome Mapping Project will foster and coordinate research leading to the ability to identify, characterize, alter, and rapidly and precisely manipulate genes underlying traits of agricultural importance to meet society's needs. Understanding the organization and function of plant genomes is crucial for the effective exploitation of genetic resources. Mapping should complement the USDA Germplasm Program. This goal recognizes the fact that agriculture is an industry based on growing plants for food, feed, fiber, and biomass. An additional outcome of the program is the training of highly skilled U.S. scientists capable of using current and future discoveries in the biological sciences for the benefit of agriculture.

Objectives of the USDA Plant Genome Mapping Program

Three major objectives were identified for the Plant Genome Mapping Program: mapping and sequencing of the plant genome; management of data, information, and resources; and identification, characterization, and expression of genes of agricultural importance as well as gene transfer technology.

Mapping and sequencing of the plant genome

Mapping and sequencing the plant genome will depend on advances in technology; therefore, the technology development should be an integral part of the USDA Plant Genome Program. The Plant Genome Project presents challenges and opportunities different from those that arise with humans, livestock, domestic animals, and wildlife. Some of the gene mapping and sequencing and data analysis technologies being developed by the DOE/NIH Human Genome efforts will be immediately applicable to the plant genome. At the same time, new technologies will have to be developed to deal with problems that are unique to plant genomes such as polyploidy, large genomes, chromosomal duplication, and the lack of variability in the self-pollinating species. Plant genome research offers particularly unique opportunities in the areas of gene evolution and quantitative genetics because plants are more amenable than animals to experimental designs that distinguish environmental and hereditary effects on gene expression.

Four specific areas of research activities were identified:

Construction of high-resolution gene maps for those plant species with sufficient background information already available (for example, tomato, corn, and rice).

Development of low resolution maps for all major crop species important to the United States about which little information is available at the moment.

High resolution mapping and sequencing of specific regions of the chromosome for investigating specific genes of economic interest (for example, hybrid vigor, disease resistance, and drought resistance).

A complete sequencing of the Arabidopsis genome.

Increased activities in these areas will facilitate the development of technologies needed and will yield tangible products in a relatively short time. The committee members agreed that efforts to map and sequence organellar as well as nuclear genomes should be included. It was further agreed that microorganisms associated with plants such as pathogens and nitrogen-fixing symbionts be included in the scope of this project.

Complete sequencing of the Arabidopsis genome was considered an important opportunity for USDA because of its scientific significance and relevance to the entire plant genome mapping effort. Sequencing the genome of a model system will reveal and make accessible genes to be sought in other, more complex plant systems and will also tell us about chromosomal mechanics of higher plants in general. Because of the small size of its genome and rapid growth in small, recurring areas, Arabidopsis was considered an ideal model system. Arabidopsis genome research has already been initiated by NSF, DOE, and NIH in this country as well as in the United Kingdom and European Community countries. USDA was urged to join NSF, NIH, and DOE as an active partner in this highly visible endeavor.

Funding priorities should be determined based on the quality of the science proposed by the investigators. The choice of commodity would naturally fall in place depending on the objective of a specific project.

Management of data, information, and resources

Management of mapping/sequence data is a high priority activity. It was recommended that a working subcommittee be assembled to assess various databases and software already available, to find out the extent of data management activities of the DOE/NIH Human Genome project, and to determine exact needs for the plant genome research community and how USDA can best meet those needs.

The committee recommended that the Office of Plant Genome Mapping serve as a clearinghouse for all information pertinent to plant genome mapping research, including database, resource material, research activities, meetings, and publications. Ideally, scientists should be able to rapidly obtain desired information through communication with the Office of Plant Genome Mapping and through the computerized referral system at the National Agricultural Library.

Management of rapidly accumulating resources such as DNA probes, DNA libraries, seeds, and blots is still a serious concern, although recent developments using polymerase chain reaction procedures may reduce or eliminate the necessity of exchanging the many DNA probes and libraries as is currently being done. Accurate descriptions of these resources need to accompany the material when it is distributed. Therefore, the researchers who actually use a certain material most often would be the most logical ones to distribute it. This kind of activity will require modest, but continuous financial assistance from USDA. Again, the existing mechanisms for distributing these resources need to be studied before some mechanism is established for the plant genome research effort. A flexible approach is needed in selecting the most suitable distribution method for a particular material in question (that is, seeds, clones, etc.).

Identification, characterization, and expression of genes of agricultural importance, as well as gene transfer technology

This represents an area of research that is the closest to the ultimate goal of the USDA Plant Genome Project. As the gene mapping and sequencing technologies and the actual maps are developed, it should be possible to apply them to identify, locate, and isolate specific genetic traits of interest and to use them for the manipulation of crop plants by genetic engineering or conventional breeding. Many areas in plant biology lack fundamental information, and this needs to be rectified before the mapping/sequencing technology and information can be used to their full potential. The USDA Plant Genome Mapping Project should support research that is designed to fill the gaps in our knowledge and to facilitate the application of mapping information for genetic engineering and plant breeding.

Approach To Accomplish the Objectives

The approach of USDA in implementing and administering the Plant Genome Project should be based on science. The project should use open competition and emphasize interdisciplinary activities. In particular, the committee stressed the need for reiterative interactions between genome researchers and plant breeders in order to achieve the objectives. Also, administrative flexibility is essential for the success of the program as specific mechanisms of funding would necessarily vary depending on the objective. For example, data management may be better handled by awarding a contract that meets specifications developed through the user's input; the best mapping project is likely to be identified by a peer review process. Involvement of the entire scientific community including private industry in open competition is a must for the success of this program.

The committee recommended that a Scientific Advisory Board be established to advise the Office of Plant Genome Mapping and that the chair of the Board be someone from outside USDA.

Recommended Activities for the Office of Plant Genome Mapping

In addition to the immediate action items listed above, the committee members made several suggestions for informational activities of the Office of Plant Genome Mapping.

Publication of a pamphlet explaining the plant genome mapping activities in layman's terms.

Publication of a periodic newsletter for the plant genome research community.

Establishment of biannual meetings of all grantees as a means of disseminating information to the interested parties.

Consideration of social concerns associated with plant genome research.

Responsibilities of the Scientific Community

The committee members expressed a strong sense of commitment to the goal of the plant genome mapping initiative. They recognized that involvement of the scientific community must be more than that of passive participants as grantees or advisors. All those present at the meeting have indicated that they are willing to actively assist USDA with their technical expertise at this critical, formative stage of the program and that they will organize themselves to provide expert testimony on behalf of the program. The scientific community recognizes the challenges in communicating to the public the importance of the plant genome mapping effort and feels that the community should make a conscious effort to promote that awareness. Finally, there was a strong agreement that support for the plant genome mapping initiative must be financed through new resources, not at the expense of existing USDA programs.

List of Participants

Dr. Charles E. Hess	USDA, Assistant Secretary for Science and Education
Dr. Machi F. Dilworth	USDA-CSRS, Co-chair
Dr. Jerome P. Miksche	USDA-ARS, Co-chair

Committee Members

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